

Vision Science IV: Principles of Binocular Vision

Examination 2

3/24/99

Maximum point total: 66

1. Calculate the maximum distance at which stereopsis can be effective if the PD is 65 and the stereoacuity threshold is 10 arc seconds. Which of the following is closest to your answer? (1)

- A. 670 m
- B. 1110 m
- C. 1340 m**
- D. 2220 m
- E. 2680 m

2. Which of the following factors both determine the relationship between horizontal angular disparity (η) and linear depth difference (ΔD)? (1)

- A. Viewing distance and PD**
- B. Eccentricity and PD
- C. Viewing distance and VA
- D. PD and luminance
- E. Viewing distance and eccentricity

3. When viewing equidistant red and blue objects binocularly, the red ones usually (but not always) appear nearer than the blue. This phenomenon can best be explained by which of the following? (1)

- A. Color opponency theory
- B. Fechner's paradox
- C. Hue shifts
- D. Ocular chromatic aberration**
- E. Phi phenomenon

4. With respect to perceived brightness, Fechner's paradox suggests that binocular sensory integration is based upon which of the following? (1)

- A. Right / left sensory independence
- B. Probability summation
- C. Physiological summation
- D. Stereocampimetry
- E. Brightness averaging**

5. If an ND filter is placed before the left eye, a swinging pendulum confined to the subject's fronto-parallel plane will appear to move in which of the following ways? (1)

- A. Swing in a clockwise elliptical pattern (closer to the subject when swinging right to left)**
- B. Swing in a counterclockwise elliptical pattern (closer when swinging left to right)
- C. Swing more slowly than its physical motion
- D. Swing in the opposite direction to its physical motion
- E. Swing in a figure eight pattern centered on the fixation point

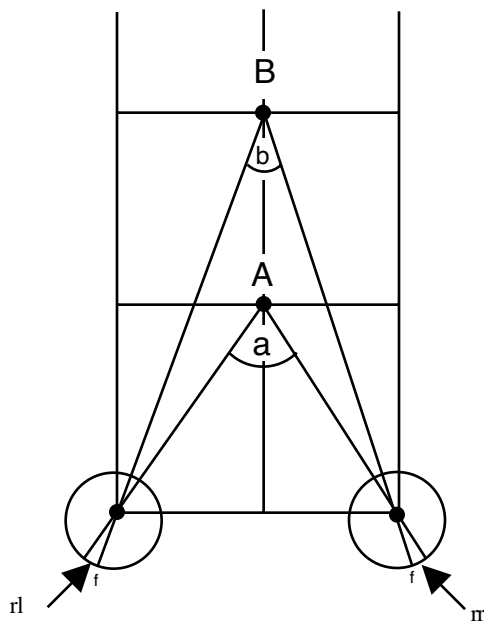
6. According to Laddy (1995), how does the visual system process depth cues, when it has access to a large amount of monocular and binocular depth data, some of which may conflict. (2)

- * It first processes depth estimates from each cue independently.
- * The various cues are weighed and integrated. Some may be ignored.

7. Which of the following is NOT associated with stereopsis? (1)

- A. Binocular parallax
- B. Absolute distance discrimination
- C. At least two objects must be seen for comparison.
- D. Horizontal disparity
- E. Apparent spatial distortion in aniseikonia

8. Referring to the figure, prove that the angular disparity (angle a - angle b) in object space is equal to the absolute sum of the retinal angular disparities (angle rl + angle rr). (4)



See Lecture 17 notes (p. 80-81).

9. What is hyperstereopsis? (1)

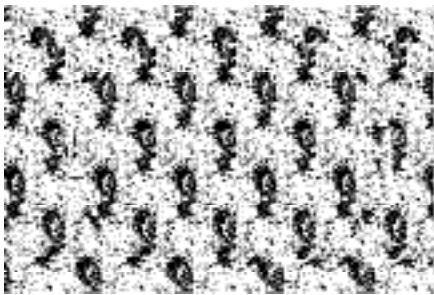
- A. Stereopsis associated with vertical disparities
- B. Chromostereopsis
- C. Global stereopsis seen in random dot stereograms
- D. Enhanced stereopsis from an optically enlarged PD
- E. Stereoacuity threshold between 2 and 10 arc seconds

10. For each of the following paired words, indicate the one that is most closely associated with the fine stereopsis mechanism in the visual system. (5)

parvo cellular system
high spatial frequencies
foveal input
fast motion
fine disparity vergence control

magno cellular system
low spatial frequencies
peripheral
slow motion or stationary
coarse disparity vergence control

11. Below is an example of an autostereogram created by Dr. Christopher Tyler (1979). Explain the basic principles of how an autostereogram works. (4)



* repetitive pattern
* eye converge one repetitive width
* this creates disparate retinal images
* disparity stimulates stereopsis
* object seen in depth

12. What important principle was demonstrated by the random dot stereograms of Julesz? (1)

- A. Monocular form perception is not required for stereopsis.
- B. Monocular form perception always precedes stereopsis.
- C. Monocular and binocular form perception are processed by the same neurological centers.
- D. Two identical random dot patterns can stimulate stereopsis.
- E. Objects located off the horopter stimulate disparate retinal points.

13. Describe how a random dot stereogram might be clinically useful. (2)

This provides an excellent way to test stereopsis in children. If they have no stereopsis, they will see no form. The form will be visible to them only if they have a stereoscopic threshold less than the disparity created in the stereogram.

14. Which of the following conditions commonly to lead to suppression of either eye? (1)

- A. Isometropic (symmetric OU) myopia
- B. Symmetric low astigmatism OU
- C. Aniseikonia
- D. Strabismus
- E. Both aniseikonia and strabismus

15. What is the difference between diplopia and confusion? (Define both) (2)

These conditions are associated with strabismus because the images falling on the two retinas are on grossly non-corresponding locations. The object that is foveally fixated by one eye, falls on a non-foveal location in the other eye and the person may see two images of the same object. This is diplopia. At the same time, each fovea is pointing to a different object and the person may see two different images superimposed on the primary visual axes. This is confusion.

16. Which of the following conditions would you most likely expect to see in a strabismic patient who has a best corrected visual acuity of 20/20 in each eye? (1)

- A. Amblyopia
- B. Alternation
- C. Aniseikonia
- D. Anisometropia
- E. Anisocoria

17. Among the following pairs of words, indicate the feature which would dominate, or tend to suppress the other in a case of binocularly rivalry. (5)

bright	dark
low contrast	high contrast
clear image	blurred image
foveal	peripheral
stationary	small motion

18. Describe how you would use Bagolini lenses and ND filters to grade the relative suppression proneness in the two eyes. (4)

When a patient wears the Bagolini lenses and views a point of light, they see a cross pattern. Add ND filters of increasing optical density before one eye and record the value of the minimum optical density, which causes one branch of the cross to disappear. Repeat the procedure with the other eye. The eye which took the lower optical density is the one that is more easily suppressed.

19. Adaptive optics allowed Drs. David Williams and Austin Roorda to obtain amazingly clear photographs of retinal photoreceptors in the living eye. What surprising discovery did they make about the retina? (1)

Since color perception appears to be homogeneous across the visual field, they expected a systematic, even distribution of S, M and L cones across the retina. Instead they found that the different cone types were arranged in a random fashion. Some places had a high concentration of L cones, while other locations had a concentration of M cones. S cones were also irregularly scattered.

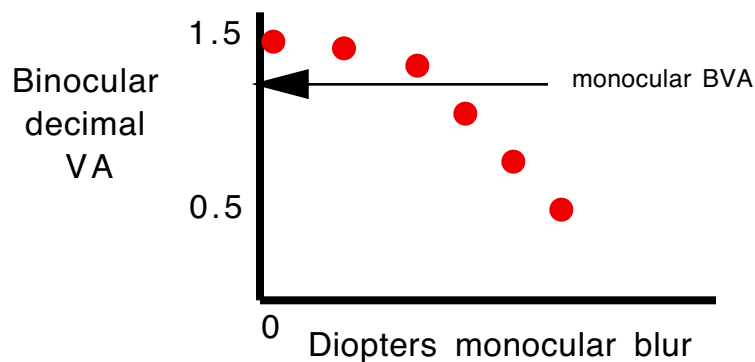
20. When viewing red-green stereograms with anaglyph glasses, the depth contours seem to

reverse when the glasses are flipped, but this generally does not occur when viewing stereograms of natural scenes. Why? (2)

Natural scenes contain abundant monocular depth cues, which conflict with the stereoscopic depth contour if the glasses are worn incorrectly. The brain must reconcile the conflicting cues; it usually favors the monocular cues and ignores the erroneous stereoscopic interpretation of depth.

21. If binocular summation is strictly due to the increased probability of detection because two rather than one eye is used (probability summation), how much would you expect binocular sensitivity to improve over monocular sensitivity? (1)
- A. No significant change
 - B. Binocular sensitivity would actually be slightly worse.
 - C. Binocular sensitivity should be about 1.4-1.5 times greater.
 - D. Binocular sensitivity would be about twice as great.
 - E. It is impossible to predict without actually measuring binocular and monocular sensitivities.

22. Complete the following graph to show the expected relationship between binocular visual acuity (y-axis) and monocular blur (x-axis). (2)



23. Which of the following describes the eye that would be considered to have sensory ocular dominance? (1)

- A. The eye which is used for sighting.
- B. The eye which notices less jump in the cover test.
- C. The eye which has the greatest impact on binocular VA when blurred monocularly.
- D. The eye on the same side as the dominant hand. For example OD for a right handed person.
- E. The eye with the lowest monocular contrast sensitivity at all spatial frequencies.

24. Before fitting a patient with monovision contact lenses you determine that they favor OD in a directional dominance test at far. A +1.50 lens held over OS causes a more noticeable binocular

blur at far than if the lens is held over OD. With the near chart, there is no clear preference for either eye with either test. Based on these findings, which eye should be fit with the near correction? (1)

- A. Both the directional and sensory tests indicate OD.
- B. Both the directional and sensory tests indicate OS.
- C. The directional test indicates OD but the sensory test indicates OS.
- D. **The directional test indicates OS but the sensory test indicates OD.**
- E. It doesn't matter since there is no clear preference at near.

25. When giving a patient yoked prism, the fixation point appears to be shifted in the direction of the apex, despite the fact that its image fall on both foveas, which have a visual direction of straight ahead. How can you explain the perceived shift in visual direction? (2)

Perceived visual direction is based on local sign (oculocentric direction) as well as proprioceptive information about the orientation of the two eyes. When the eyes rotate to follow the shifted image, the visual system senses that the object has shifted in that direction, even though the local signs alone indicates a straight-ahead direction. All directions are ultimately egocentric.

26. Before prescribing BO prism, you advise the patient that they may notice a slight distortion of their space perception, when they begin to wear the new glasses. Which of the following is NOT expected with BO prism? (1)

- A. A flat wall may appear bowed toward the patient.
- B. **Other people may appear taller.**
- C. The person may feel taller.
- D. Parallel vertical lines may appear bowed inward.
- E. The floor may appear to slope downward, away from them.

27. Name two problems, associated with spectacle correction of anisometropia that can cause asthenopia. (2)

Aniseikonia and anisophoria

28. Briefly describe how the principles of visual space perception with were used to created very realistic virtual people in the film *Titanic*. (2)

Normally realistic human movements are very difficult to create in an animated film. Using the technique of motion capture, the creators of *Titanic* were able to gather biological motion data of real human actors. The movement data was combined with computer graphics images of people to create amazingly realistic images of living, moving people.

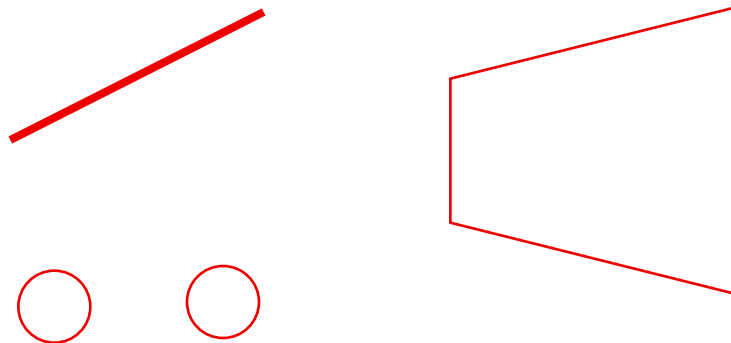
29. Considering only the magnification effects caused by the spectacles, how would you expect visual space to be distorted if a person the following Rx? (1)

OD -2.00 sph
OS -5.00 sphere

- A. The wall would appear tilted away on the left side.
- B. The wall would appear tilted away on the right side.
- C. A flat wall would appear to become concave toward the patient.
- D. The top side of a wall would appear larger and tilted away from the patient.
- E. The geometric and induced effects would cancel and the wall would be perceived correctly.

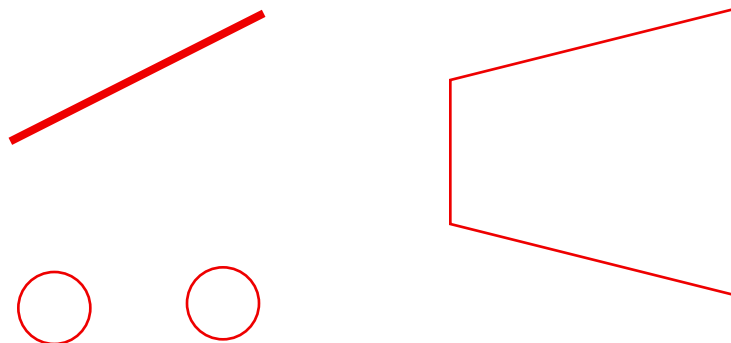
30. Draw a diagram (top and front view) to indicate how a patient's perception of a fronto-parallel rectangle would be distorted based on the magnification effects of the following spectacle prescription. (2)

OD -1.25 - 2.00 x 180
OS -2.75 sphere



31. Draw a diagram (top and front view) to indicate how a patient's perception of a fronto-parallel rectangle would be distorted based on the magnification effects of the following spectacle prescription. (2)

OD +2.00 - 2.00 x 090
OS +0.50 sphere



32. Assuming a spectacle lens with a convex front surface, how would you modify the following parameters to increase spectacle magnification (larger image) using the shape factor? (3)

Center thickness: **thicker**
Refractive index: **lower**
Front curve: **steeper**

33. If Knapps law were applicable, would spectacles or contact lenses be recommended for an axial anisometrope? (1)

spectacles

34. What factors other than the spectacle magnification affect the actual perceived aniseikonia in a patient with anisometropia? (4)

Different optical magnification of the eyes themselves
Distribution of retinal photoreceptors
Neural processing
Adaptation to aniseikonia